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A Well Kept Secret

American agriculture today seems to be privy to a well kept secret. In many parts of the country, slowly but surely—in some places not so slowly—our top soil is washing away.

Soil erosion by water is now a major problem on more than half of the 450 million acres of cropland in the United States, and on much of the 800 million acres of pasture and rangeland, as well. Agricultural scientists have long been concerned about soil erosion. Current estimates place the amount of soil eroded each year at more than 4 billion tons.

Soil erosion is averaging 9 tons per acre annually from U.S. farms, while new topsoil forms at a rate of a small fraction of a ton per acre each year. In some states, the erosion figure is higher. Iowa, for example, is losing topsoil at the rate of 13 tons per acre each year, and the land has already begun wearing thin in the southern part of the state. During the century that Iowa has been cultivated, it has lost half of its original 16 inches of topsoil.

Although diminished returns, loss of nutrients, and increased fertilizer costs are plaguing farmers whose topsoil is eroding into nearby rivers, these are not the only problems they face. Farmers, like all of us, must contend with the effects of nonpoint source pollution—pollution whose specific source is not clearly identifiable.

Advances have been made in erosion control technology during the last 40 years but, during that time, the complexity of erosion control has increased. Tractors have become larger and heavier, farms have become larger and less labor-intensive; terracing and strip cropping have become less workable. With these changes, effective, economical erosion control practices have grown increasingly difficult.

The loss of soil from America's farmland affects everyone; higher consumer prices for food and other products are as real to the nonfarmer as they are to the farmer. Nevertheless, soil erosion in this country has received little national attention outside the agricultural sector.

This situation must be corrected before appropriate national resources, including appropriate national concern, can be marshalled, and effective solutions adopted. The challenge of soil erosion to American agriculture has been a well kept secret—one that it can ill afford to keep.—R.W.D.

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COVER: Hunting on top an alfalfa leaf, a seven-spotted ladybird beetle captures one of her favorite dinners—a pea aphid. Imported from Europe, this variety of beetle has now been established in America to help control certain aphid species (0678X780–17). Story begins on page 8.

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Bob S. Bergland, Secretary
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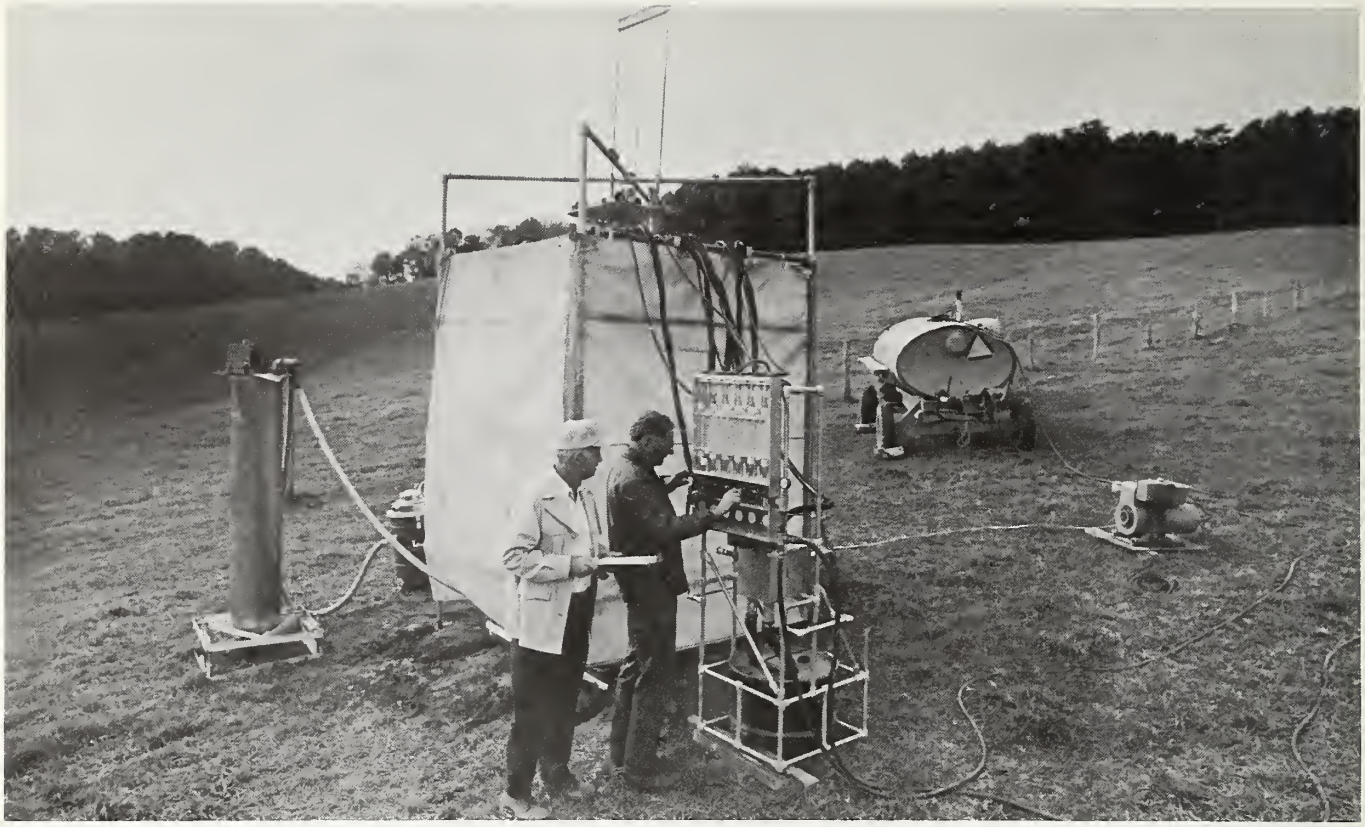
Before "turning on the rain," hydraulic engineer W. Russell Hamon makes a final check of the rainfall simulator. Flaps prevent the wind from disturbing the rainfall pattern. The test plot measures 6 feet square, and the raindrops fall 8 feet to achieve 75 percent of normal rainfall velocity. Vertical pipes in the foreground house a dual gamma probe system which measures soil density changes as the water is applied. Rainfall simulation periods usually last 1 to 3 hours (1078X1325–30A).

New System Simulates Rainfall

IMPROVED watershed runoff predictions will result from an infiltrometer system capable of simulating natural rainfall at a wide variety of intensities.

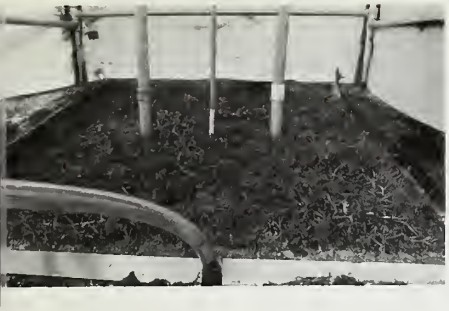
Watershed surface runoff is one of the most important sources of water for Western agriculture. Infiltration—the amount of water that goes into a watershed's soil—determines how much surface runoff will come from a watershed.

Ideally, to measure infiltration, an infiltrometer system should be able to reproduce natural rainfall as closely as possible and to measure surface runoff and water movements into the soil during and after rainfall application. Previous infiltrometer systems could only apply fixed rates of water and could



Above: Mr. Hamon and cooperating state technical assistant Ronald Whipkey set up their portable rainfall simulator on a test plot at SEA's North Appalachian Experiment Watershed in Coshocton, Ohio (1078X1325–11A).

Right: At the rainfall simulator's control module, electronic technician David Gallwitz monitors water flow meters and air pressure gauges to ensure proper rainfall rates and droplet size. Total rainfall can be set anywhere from .15 to 8 inches per hour (1078X1326–5).



Left: A vacuum hose collects surface runoff water for measurement against total rainfall to determine how much water infiltrated the entire test plot (1078X1326–18).

Right: Weight of surface water vacuumed off a test plot is charted on a portable analog data recorder, here being adjusted by hydrologic technician Steven Storm (1078X1326–31).

Below: To determine the amount of water absorbed by soil subjected to a specific intensity of simulated rainfall, the soil is evaluated through physical extraction and neutron bombardment before and after the rainfall is applied. Ronald Whipkey (left) pushes a soil sampler into the ground while Steven Storm lowers a neutron probe into a 4-foot tube for radioactive measurements of the soil at depth intervals of 6 inches (1078X1327–33A).

not monitor soil water.

Besides simulating natural rainfall, the new infiltrometer system can do other things no other system can, such as measuring soil moisture content during actual runoff down to any desired depth. Also, the new system is fully portable, enabling its use at different sites.

The new infiltrometer system was designed and tested by researchers at SEA's Northwest Watershed Research Center, Boise, Idaho, in cooperation with the U.S. Bureau of Land Management and the University of Idaho Agricultural Experiment Station. This phase of the project was led by SEA hydraulic engineer W. Russell Hamon.

SEA hydraulic engineer Donald L. Brakensiek is currently developing data analysis procedures to simplify the application of the infiltrometer system so that the U.S. Soil Conservation Service can use the system to estimate the infiltration rates of benchmark soils all over the country.

Dr. Donald Brakensiek is located at Patti Plaza, Suite 116, 1175 South Orchard Street, Boise, Idaho 83705. Mr. W. Russell Hamon is now located at North Appalachian Experiment Watershed, P.O. Box 478, Coshocton, OH 43182.—*L.C.Y.*

Farming Trends Affect Soil's Future

THREE farming trends in the Northern Corn Belt may produce subtle and counterbalancing effects on soil and its productivity. SEA soil scientist Ward B. Voorhees, Morris, Minn., identifies these trends as increased weight of farm machinery, increased use of conservation tillage and decreased use of crop rotations that include hay.

Soil compaction, organic matter content of soils and the size and stability of soil aggregates are all affected by the trends, Voorhees says. Findings from his studies at the Southwest Minnesota Experiment Station near Lamberton may apply generally to areas besides the Northern Corn Belt.

The soil scientist says that today's 15-ton tractors, which allow farmers to complete field work in a timely manner, may actually minimize soil compaction because of their low-pressure tires and because of fewer trips across the field. But if the big rigs are used to work the ground when it is too wet, compaction may hamper water infiltration and limit root growth and crop yields for years to come.

Future productivity of the soil also may be diminished by prevalent crop rotations. Voorhees says erosion that often accompanies rotations with intensive cultivation reduces organic content of the soil, diminishing tilth. He defines good tilth as a physical condition of the soil that makes it easy to till and fit as a seedbed where seedlings emerge and roots penetrate readily.

Good soil tilth is associated with a high degree of aggregation of soil particles into granules or small crumbs, Voorhees says. A decrease in aggregation caused by a decrease in the soil's organic content may be offset by an increase in aggregate size caused by wheels of farm tractors and implements pressing against the soil.

Wheel-induced soil compaction, how-

ever, may not be a desirable way to improve aggregation. Before spring tillage began, Voorhees found that diameters of aggregates in wheel tracks from a previous year averaged 3.8 centimeters (cm) compared with 0.7 cm in nontracked soil. The nontracked soil would have been satisfactory for seeding with no further tillage because 0.5 cm is considered the optimum average diameter. But additional tillage needed to reduce the aggregate size in tracked soil also would have reduced further the aggregate size in nontracked soil, creating crusting and seedling emergence problems.

Voorhees also found that compaction caused by three passes of an 8-ton tractor and equipment can exclude root growth from 60 percent of the top foot of soil. Consequently, much of the fertilizer incorporated into the soil remained out of reach of plant roots.

Compaction does not always reduce crop yields, however. Voorhees has documented instances of increased soybean yield with moderate compaction in dry years.

Yet, compaction may build up from one year to the next on land that is continually row-cropped. In this situation, farmers may have to use increased amounts of fuel for tillage. And the soil compaction may be especially difficult to alleviate below normal tillage depths.

In the tilled zone of soil, fall tillage was more effective than freezing and thawing in ameliorating soil compaction. Moldboard plowing was more effective than conservation tillage such as chisel plowing or disking in the Minnesota studies. Conservation tillage, however, may increase the organic content of soil, improving tilth in the long term, the scientist says.

Voorhees says the trend to increased conservation tillage may not be fully appreciated for its impact on organic content of soil for many years. But conservation tillage obviously is already appreciated for other reasons. The soil scientist notes that by 1977, conservation tillage was used on about 43 percent of Iowa's row crops.

Ward B. Voorhees' address is USDA-SEA, North Central Soil Conservation Research Laboratory, Morris, MN 56267.—*G.B.H.*

Infection Causes Swine Dysentery

Pigs grown under usual farm conditions developed typical lesions of the colon and clinical signs of swine dysentery when orally inoculated with a pathogenic strain of *Treponema hyodysenteriae*.

So *T. hyodysenteriae* causes swine dysentery? No, not by itself, says SEA veterinary medical officer Shannon C. Whipp.

This pathogen alone produced neither clinical signs nor visible colonic lesions in germ-free pigs similarly inoculated by scientists at the National Animal Disease Center and Iowa State University, Ames. The scientists concluded that another anaerobic organism normally present in the intestinal tract of pigs plus *T. hyodysenteriae* must cause the acute diarrheal disease, which is also known as bloody scours.

And disease was produced when they infected germ-free pigs with *Bacteriodes vulgatus* and *T. hyodysenteriae* together. *B. vulgatus* is one of several intestinal anaerobes isolated from normal pigs.

The obvious next question to be answered by Dr. Whipp, SEA microbiologists Isadore M. Robinson and Deane Dennis and Iowa State microbiologist Delbert L. Harris was: Is *B. vulgatus* the only normally present anaerobe that works in concert with *T. hyodysenteriae* to produce swine dysentery? If so, perhaps the disease could be prevented or treated by measures directed at *B. vulgatus*.

Further research produced a negative answer to this question.

Apparently typical cases of swine dysentery were produced in germ-free pigs orally inoculated with pathogenic *T. hyodysenteriae* together with *B. vulgatus, Fusobacterium necrophorum*, or both. Six other anaerobes isolated from pigs also cause disease when present with *T. hyodysenteriae*, but not when present alone.

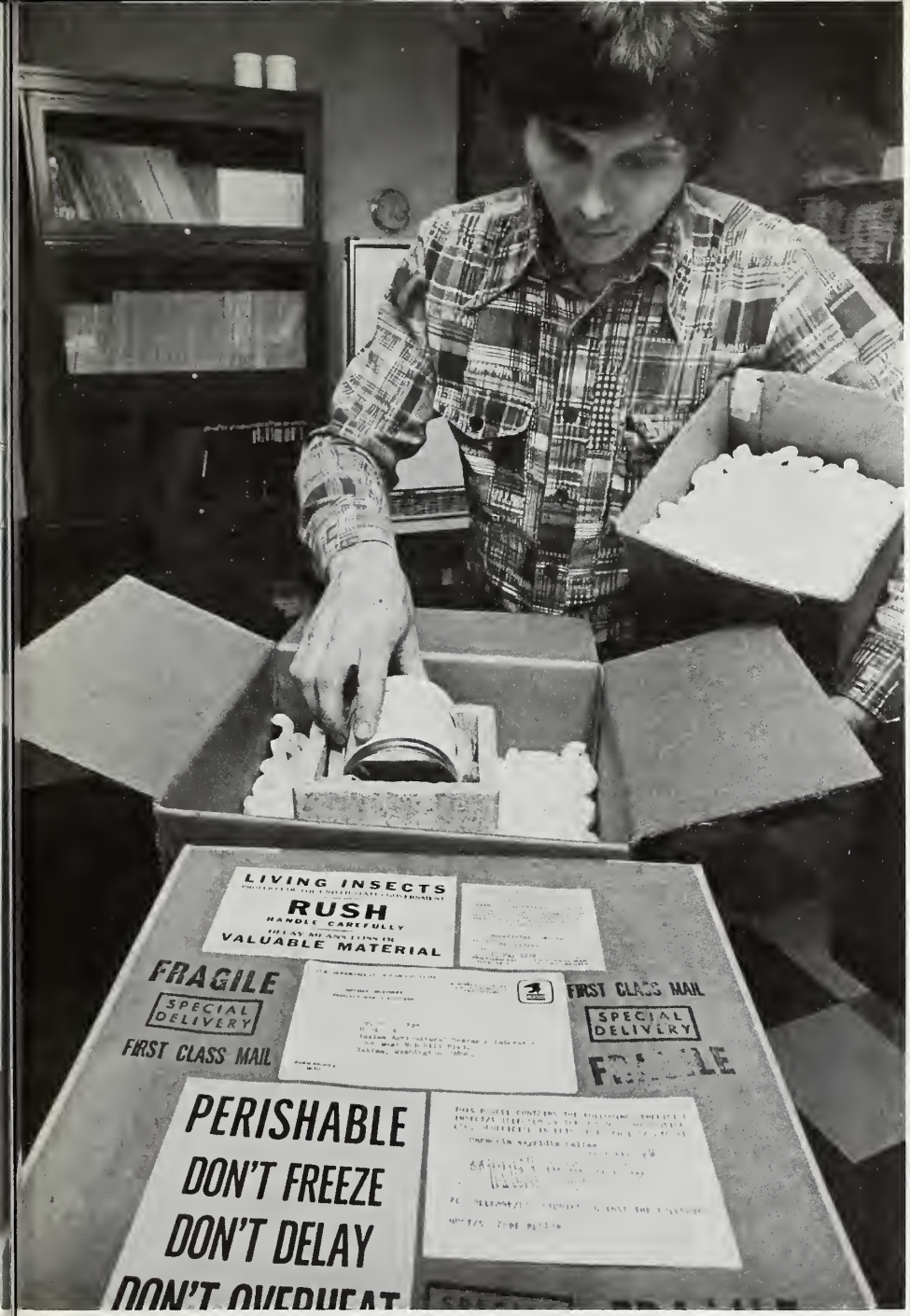
The researchers concluded that *T. hyodysenteriae* is the principal pathogen in development of swine dysentery. Certain anaerobes are required to activate the principal pathogen, but this requirement is not specific—it can be met with a variety of anaerobes.

Still to be determined, says Dr. Whipp, is the answer to the question: "What factors do these other organisms provide that allow *T. hyodysenteriae* to cause disease?" Further study of the intestinal anaerobes normally present in pigs may define the mechanism producing swine dysentery.

Dr. Shannon C. Whipp is at the National Animal Disease Center, P.O. Box 70, Ames, IA 50010.—*W.W.M.*

Aphid Predator Now Established in U.S.

Ladybird beetles in thick-matted red top grass, a favorite hibernating spot for the winter (1077X1396–18A).



Quarantine officer Lawrence Ertle packs "friendly" insects (such as the seven-spotted ladybird beetle) for shipment to strategic locations where they will be released to breed into armies of parasites and predators marching against unwanted insect pests (0578X599–7).

THE seven-spotted lady bird beetle, *Coccinella septempunctata L.*, is now established in the United States and reports indicate that it is doing a good job of controlling several species of aphids. The beetle, a cousin of the American ladybug, is the most important aphid predator in Europe and North Africa.

The first generation of the beetle was recovered during the 1950's in New Jersey, Ohio, and California fields where it had been released. However, there was no evidence of its permanent establishment in the continental United States until 1973 when Dr. Richard L. Jacques, a biologist at Fairleigh Dickinson University, Rutherford, N.J., discovered a large population of the beetle in the Hackensack Meadowlands, a tidal marsh in northern New Jersey a few miles west of New York City.

Whether the Hackensack establishment of the seven-spotted ladybird beetle resulted from the many releases made over the years in the eastern United States, or resulted accidentally from unknown sources, it is apparent that the beetle had been present at the site for awhile.

Armed with this new population, scientists at the SEA Beneficial Insects Research Laboratory (BIRL) in Newark, Del., began yet another effort in 1974 to Americanize the seven-spotted ladybird beetle. Since then, they have sucessfully established the beetle in Delaware, Georgia, and Oklahoma. Other releases have been made in Ohio, Illinois, Washington, Texas and New Mexico, but definite establishment in these States will not be known until 1979.

During the spring of 1977, BIRL project leader George Angalet observed that the beetle was the most important aphid predator in the BIRL alfalfa plot and also controlled several species of aphids in the BIRL vegetable garden.

Mr. Walker L. Tedders, an entomologist with the SEA Southeastern Fruit and Tree Nut Research Laboratory in Byron, Georgia, found that the beetle was the most abundant aphid predator on the lab's legumes and fruit trees during the spring of 1977. The beetle was released in the Byron area in 1976.

In Oklahoma, Dr. Ray D. Eikenbary of Oklahoma State University's entomology department reports the beetle feeding on several species of aphids including the greenbug, a serious pest of cereal grains.

BIRL surveys show that the strain of *Coccinella septempunctata* being released at the present time is not as mi-

gratory as the ladybird beetles released in the past, nor as migratory as many native species in the USA. At the three establishment sites in Delaware, Georgia, and Oklahoma, the beetle has not left the immediate area, although a few adults have been collected as far as 3–7 miles (4.8–11.2 kilometers (km)) away. Small colonies have been found in New Jersey only as far as 45 miles (72.5 km) west and 35 (56.4 km) miles south of the Bergen County site, and also in Fairfield and New Haven, Conn., with the farthest establishment 100 miles (161.3 km) east at Hammonassett State Park in Conn.

This lack of migration is useful in establishing the beetle as it allows scientists to manipulate *C. septempunctata* releases in those areas of the United States where aphids cause economic damage to crops.

The original establishment site in the Hackensack Meadowlands is rapidly being destroyed by an expanding landfill, reducing the numbers of *C. septempunctata* that can be collected. Attempts are being made at Newark, Del., to determine if the beetle can be mass-reared in sufficient numbers to supplement the field-collected insects.

It is also hoped that large numbers can be obtained by establishing the seven-spotted ladybird beetle in an extensive alfalfa field heavily infested with pea aphids. If this can be accomplished, it should be possible to collect 25,000 to 75,000 (6.1 to 18.5 million per hectare) beetles per acre, provided sufficient host material is available.

If sufficient numbers of *C. septempunctata* can be obtained so that large-scale distribution of this aphid predator can be carried out, it should prove a successful biological control for many species of aphids in the United States.

Mr. George W. Angalet is with the Beneficial Insects Research Laboratory, 501 South Chapel Street, Newark, DE 19713.—*M.A.M.*

Draw play: A miniature, battery-operated vacuum cleaner helps entomologist George Angalet collect ladybird beetles in the Hackensack Meadowlands just outside the N.Y. Giants football stadium

Above: Agricultural research technician Joseph Tropp checks ladybird beetles collected in his specially designed large size aspirator. After collecting roughly 400 beetles, they are placed in a half-gallon paper container (0578X601–10A).

Right: Growing plants for hosts of predators and parasites is an important part of the BIRL operation. Here, University of Delaware student Rosemary Speck, a helper with the laboratory, sprays alfalfa with a chemical to control slugs (0678X777–27).

Conserving Potable Water

Food safety and water and energy conservation are the tunes a broiler processor today must dance to. Part of the "music" is law; part is preference.

Regulatory agencies require the use of potable water in all phases of broiler processing, except by petition in scalding. But by reusing water from the bird chiller in certain other phases of processing, a plant could save 35,000 to 100,000 gallons (132.5 to 379 kiloliters) of potable water per day—or 9 to 26 million gallons (34,110 to 94,750 kiloliters) per year.

"The reuse of chiller water could save the whole industry an annual 3.6 billion gallons of potable water and discharge," says SEA research food technologist Huda S. Lillard at the Environmental Engineering Laboratory, Russell Research Center. "In addition to water shortages experienced in some areas of the United States, the cost of potable water and effluent discharge is expected to rise. The cost of potable water reported by one processor in Georgia, including effluent discharge, was about $27,000 per month. The high cost is either passed on to the consumer or absorbed by the processor who must compete with processors in areas where expenses are lower."

In an earlier study, Dr. Lillard filtered bird chiller water through diatomaceous earth (material derived from algae and used in industry as a filter aid) in a pressure leaf filter to remove organic matter. This made chlorination of water possible at low levels.

"The filtered chlorinated chiller water was very clear, visually very similar to potable water, and was neither esthetically nor microbiologically objectionable," Dr. Lillard said.

Under present Federal regulations, products flumed (transported or conveyed in water through a series of pipes) with other than potable water may not be sold. In a current study to determine the feasibility of fluming giblets with treated chiller water instead of potable water, Dr. Lillard used only necks, economically more feasible to the processing plant.

The microbiological quality of necks flumed commercially with potable water was then compared to quality of necks flumed in a simulated giblet flume with potable water, filtered bird chiller water, and filtered, chlorinated chiller water.

A one-fourth scale simulated giblet flume was constructed in an area removed from the main processing area of the plant. The simulated flume was constructed so that giblets could be flumed with water from a potable source or with chiller water filtered with the diatomaceous earth (DE) filter. The necks were in the flume about 80 seconds and there were about 100 necks to every 10 gallons of water, the same as in the commercial neck flume of the plant.

Water from the bird chiller overflow was pumped to the DE filter. Filtered water with and without chlorination was collected in a tank for the simulated line.

A large-mesh screen cover with sterile cheese cloth was placed over a barrel for aseptic collection of giblets from the simulated flume.

Results showed that within each of four experimental time periods, there were no significant differences in incidence of salmonellae, levels of total aerobic organisms or fecal coliforms (colon bacillus) between necks flumed commercially and necks flumed in the simulated line with potable, filtered or filtered, chlorinated chiller water.

Samonellae were not isolated frequently from the filtered chiller water. However, all neck samples were salmonellae negative even on days when the filtered water was salmonellae positive.

When data from the experiments was pooled, mean days of shelf life did not differ significantly between necks flumed commercially and necks flumed with potable water in the simulated line. No chlorine odor was detected in any of the samples flumed with filtered, chlorinated chiller water.

Fluming with potable water represents the best currently available technology, and therefore, necks from the commercial flume represent the best currently attainable standard of quality and safety, Dr. Lillard emphasizes. But this study has shown that this standard can be met with water of less than potable quality, and that necks flumed with DE-filtered chiller water are microbiologically equal in all respect to necks flumed with potable water.

Fluming giblets with filtered chiller water would not only save potable water and energy, but it also would reduce the amount of water and the level of organic matter passed into municipal waste treatment systems.

Dr. Huda S. Lillard is with Russell Research Center, P.O. Box 5677, Athens, GA 30604.—*P.L.G.*

Research Advanced in Mycoplasmal Pneumonia

DEVISING techniques for study of some animal diseases can be a challenge. Such a disease is mycoplasmal pneumonia, which is costing the swine industry $1.50 to $2 per pig and may be the world's most important swine disease.

SEA microbiologist Phletus P. Williams at the National Animal Disease Center has found ways around three roadblocks to progress in developing more effective control of mycoplasmal pneumonia.

The disease is caused by *Mycoplasma hyopneumoniae*, which produces a subtle form of pneumonia that may escape observation unless pigs are under stress. But rate of gain and feed-conversion efficiency are impaired, and pigs weakened by mycoplasmal pneumonia may be more susceptible to other diseases.

The mycoplasma, which lacks a cell wall, invades spaces between cells in the lungs and coats itself with proteins of the host animal. The pig's body therefore does not recognize it as an invader and apparently does not attempt to neutralize it. The mycoplasma stops motion of cilia and breaks them off. Cilia are hairlike projections of tracheal and bronchial passages that help protect the body against invaders.

The researcher needs disease-free animal subjects. But perhaps half of the pigs in this country show lung lesions produced by *M. hyopneumoniae*, and most of the remainder are carriers of the pathogen. Dr. Williams assures that pigs for research are free of *M. hyopneumoniae* by obtaining hysterectomy-derived pigs maintained in a germ-free environment from moment of delivery.

The scientist must also be able to grow the disease agent in the laboratory. *M. hyopneumoniae* has demanding requirements and will not grow in standard culture media. Dr. Williams, however, has succeeded in growing the pathogen in cell-free media. Preventing overgrowth by other kinds of mycoplasma proved difficult because they are little affected by most antibiotics used in media preparations.

Dr. Williams also wanted to observe subtle changes, and the sequence of changes, in lung tissue during development of the disease. These changes are difficult to see in the living animal. But conventional methods of organ culture are unsatisfactory because lung tissue collapses rapidly.

The microbiologist devised a way of maintaining uncollapsed lung tissue up to 2 months. He first filled lungs of germ-free pigs with a warm culture media, phosphate-buffered silicone agar. When the media cooled and became firm, the agar-filled lungs could be sliced into thin sections that retained their natural shape.

With these techniques, Dr. Williams can duplicate in the laboratory the effects produced by the mycoplasma in lungs of ill pigs. In cultured thin sections of lung tissue as in the case of ill pigs, *M. hyopneumoniae* isolated from infected lungs stops the movement of cilia, and then causes the cilia to become entangled and eventually to break off.

Now that he has overcome some restraints in conducting research on mycoplasmal pneumonia, Dr. Williams can pursue studies on potential control methods. He has identified 19 of 51 antimicrobial agents as potentially useful in treating herd outbreaks of mycoplasmal pneumonia and can now make detailed evaluation of their value.

Dr. Phletus P. Williams is at the National Animal Disease Center, P.O. Box 70, Ames, IA 50010.—*W.W.M.*

More Beef Without Nitrogen

APPLYING nitrogen fertilizer to tall fescue-ladino clover pasture failed to increase beef production in a 4-year experiment. Although carrying capacity of the pastures increased, scientists observed declines in calf-weaning weights and cow-conception rates in spring-calving herds.

SEA agronomist Arthur G. Matches and his colleagues of the Missouri Agricultural Experiment Station, Columbia, associated the calf-production declines with decreased percentages of clover in grass-legume mixes.

The study, conducted at the University of Missouri's Forage Systems Research Center near Linneus, Mo., showed that providing creep feed for calves might be an alternative to fertilizing the pastures with nitrogen for increased beef production. The researchers figured that creep feeding would be profitable when the feed costs $0.05 per pound and the calves could be sold at weaning for $0.65 per pound.

In the experiment, calves were either creep fed or not on pastures that were fertilized annually with nitrogen at rates of 0, 100, and 200 pounds per acre. Creep feed boosted calves' total weight per acre by 50 pounds or more on pastures with each fertilizer rate.

Dr. Matches says that 200 pounds of nitrogen per acre increased the carrying capacity of pastures by about 39 percent. But weights of the noncreep fed calves on the heavily fertilized pastures were about 30 pounds lighter per acre than on pastures where no nitrogen was used.

In the last year of the Missouri study, pastures with no nitrogen had average botanical compositions of about 11 percent clover, 87 percent fescue, and 2 percent weeds. In contrast, composition of the pastures fertilized heavily with nitrogen averaged 0.2 percent clover, 96 percent fescue and nearly 4 percent weeds.

Cows on pastures which had the best ladino had the highest conception rates. This and other studies have shown declines in conception rates when cows grazed tall fescue pastures.

Dr. Arthur G. Matches' address is USDA, SEA, Agricultural Research, Room 207 Waters Hall, University of Missouri, Columbia, MO 65201.—*G.B.H.*

Protecting Stored Grain

SMALL farms may produce no more than 30 to 35 bushels of grain to meet a family's needs in food-deficit areas of the world such as Ethiopia. And up to 40 percent of this meager grain supply may be destroyed by insects during storage.

But SEA research in Kansas suggests a way of protecting a family's stored grain where temperatures are very high and humidity is low, as in the Sahel region of Africa.

Insecticidal protective dusts could be prepackaged according to the normal capacity of family storage structures for distribution in such areas, research by the late SEA entomologist Delmon W. LaHue suggests. No special equipment would be needed for application, and grain can easily be washed free of the dusts before use.

The entomologist simulated Sahel storage conditions by air-drying Scout wheat to 11.2 percent moisture while experimentally exposing the grain to rice weevils, maize weevils, and red flour weevils. After removing the insects, he warmed the grain to about 104° F. (41° Celsius), then maintained the wheat in 4-quart jars at 86° F. (33° Celsius) and 40 percent relative humidity for 8 months. In untreated wheat under these conditions, numbers of live adult weevils built up to 1,041 per covered jar by the fifth month.

Mr. LaHue prepared insecticidal dusts by mixing either pirimiphos-methyl or malathion with diatomaceous earth, and applied the dusts to the warmed, infested wheat.

Pirmiphos-methyl dust was more effective than malathion dust at each of three comparable dosage levels. Diatomaceous earth alone reduced but did not eliminate insect infestations.

Pirimiphos-methyl gave complete protection for 8 months at 7 parts per million (ppm), eliminated infestation by the fifth month at 6 ppm and by the seventh month at 4.5 ppm. A 10 ppm dosage of malathion eliminated adult weevils after the fourth month, and 7.5 and 5 ppm rates reduced weevil numbers enough that damage to wheat was relatively light.

Pirmiphos-methyl has been promising as a grain protectant under experimental conditions but is not registered for this use by the Environmental Protection Agency (EPA). Malathion has EPA approval for use on stored grain. The insecticidal dust formulations would require EPA registration before they could be recommended.

This research was conducted at the U.S. Grain Marketing Research Laboratory, 1515 College Avenue, Manhattan, KS 66502.—*W.W.M.*

Swine Reproduction Problems Linked to Confinement

A PIG penned in is not, apparently, the most productive pig.

With rising land, feed, and labor prices and the increased technology of swine production, more swine producers are turning to total confinement rearing of pigs. But as swine producers convert to total confinement systems, they are encountering abnormal reproductive patterns.

These include delayed puberty, abnormal estrous cycles and estrous symptoms, decreased conception rates, and reduced litter sizes.

Estrous cycle refers to the time from the beginning of one period of estrus to the beginning of the next. Estrus is the behavioral state the animal is in to accept the male.

Scientists estimate that puberty is delayed by 30 to 90 days, the incidence of estrus is 30 percent, and conception rate is reduced to as low as 50 percent in confined gilts.

"If the conception rates could be increased 20 percent, the incidence of no estrus reduced 15 percent, and the age of puberty reduced 30 days, there could be a potential annual industry savings of more than $200 million," says SEA animal physiologist Robert R. Kraeling.

Very little research data is available to define the physiological mechanisms causing these problems. SEA Russell Research Center and University of Georgia scientists have begun their investigations by examining the effect of total confinement on 57 crossbred gilts, raised in confinement, and divided into 2 groups.

At 100 days of age, roughly half of the gilts were confined in a single pen in the confinement finishing unit, and the rest were moved to an outside lot where they were not confined. Beginning at 150 days of age, all gilts were checked daily with two boars, alternated between confined and non-confined gilts, to determine age at first estrus. Age at first ovulation was determined by assay of weekly blood samples for progesterone. By 250 days of age, 22 of the 29 non-confined gilts had exhibited estrus compared to 10 of the 28 confined gilts.

Total confinement definitely delayed the onset of puberty; this delay was not due to gilts ovulating without exhibiting estrus (silent estrus), but was due to actual delay in ovarian function.

This same experimental procedure will be performed with fall-born gilts because there are indications that spring-born gilts, such as those used in the first experiment, tend to reach puberty later than those born in other seasons.

"Once we have established the effect of season on ovulation and estrus in confined gilts, we can begin to study the physiological parameters that are

Dr. Kraeling prepares to inject confined pigs with ACTH, a pituitary hormone solution that stimulates secretions of cortisol—a hormone relating to stress. Pigs in outdoor lots are also injected with ACTH. Subsequent serum analyses for both groups will indicate whether pigs in confinement respond to ACTH "challenges" with higher secretions of the stress-related hormone (0878X1151–19A).

affected by confinement," says University of Georgia animal physiologist George B. Rampacek.

The current theory is that confinement is a stress on the animal and it is this stress that causes the reproductive problems. But there is no data, say the scientists, to indicate that confinement actually is a stress. It is possible that confinement is a *lack* of stress on the animal. One pertinent question, for example, would be: are the adrenal glands secreting too much of certain hormones because of stress, or is the pig literally "bored," causing too little production of these hormones?

In either case, say Rampacek and Kraeling, the functioning of the adrenal glands and other endocrine glands will have to be characterized in order to form a logical explanation of the confinement problem confronting swine producers.

Recently the findings of an experiment to study the effects of crowding in confinement conducted at the Roman L. Hruska Meat Animal Research Center, Clay Center, Nebr. (AGR. RES., Oct. 1978) did not agree fully with the Georgia data. However, as was pointed out by the Nebraska scientists, genotype of the animals profoundly influenced the time of first estrus in gilts raised in confinement. The Nebraska study utilized purebred gilts while the Georgia study used crossbred gilts. The previously reported Nebraska study also involved only swine tested indoors, while the Georgia study tested swine both indoors and outdoors.

Several factors may account for differences in data from these studies. "Besides genotype of the swine, geographical location and season of the year when the studies were conducted are important considerations," said Dr. Kraeling.

Dr. Robert R. Kraeling is with the SEA Russell Research Center, P.O. Box 5677, Athens, GA 30604, and Dr. Rampacek is with the Department of Animal and Dairy Science, University of Georgia, Athens.—*P.L.G.*

Increasing Cotton Yields

A FRIENDLY rivalry has existed between growers and researchers on crop yields ever since the first test plot was established. Using cotton yields as the indicator, scientists compared county yield records of growers with yield data from Regional Cotton Variety Test Programs in the same vicinity for a 15-year period. They sought answers to the following questions:

Do yields vary between regions? Who has the greatest yields? Has there been an improvement in yields over the years?

Overall, the data reveal that growers obtain 60 percent of the yield that is achieved by researchers in test plots. There has been a slight increase in yield in recent years.

A region by region analysis revealed that the Western Region had the highest yields with an efficiency of 81.5 percent. No major differences were noted between the Plains (58.2 percent), Delta (57.1 percent), and Central (50.2 percent) Regions. The Eastern Region was significantly lower with an efficiency rating of 45.1 percent.

Numerous explanations could be offered for the wide difference between growers yield and test plot yield. In two or three instances an agronomist at one of the 24 experiment stations in the test may have added supplemental irrigation not available to local growers, or selected above-average soil for the test. Small test plot weights also usually calculate slightly higher yield than yields harvested from large fields. In most cases, however, the basic resources used by growers were equivalent to those available to experiment station agronomists.

This is not to imply that growers should be expected to achieve the yield of experimental plots. Using current information and resources, considerable potential does, however, exist for cotton growers to increase yields. Researchers and extension workers must meet the challenge of disseminating the "know-how" of higher yields to growers. Think what it would mean to raise cotton yields from 60 to 80 percent.

Researchers John H. Turner and Harmon H. Ramey, Jr., are located at the USDA Cotton Spinning Laboratory, University of Tennessee, Agricultural Campus, Knoxville, TN 37916.—*E.L.*

Wee Weevil Works Wonders

RHINOCYLLUS CONICUS is a weevil with no common name. If the tiny insect continues to control the musk thistle, farmers and ranchers should be only too happy to learn its Latin name.

Musk thistle is a noxious weed that grows over 6 feet tall in its second year and rapidly crowds out other plants. Musk thistle grows almost everywhere, but fluorishes best in river drainages and pastures which often makes chemical control impractical.

Though musk thistle came to this country from Europe, the plant is not a serious problem there because of controlling agents such as *Rhinocyllus conicus*. The weevil lays its eggs on the plant's buds. Hatched larvae then burrow into the bud and feed in the base of the flower, damaging some seeds and preventing other seeds from developing.

Rhinocyllus conicus larvae can reduce musk thistle seed production by 98 percent. Though the plants which are attacked survive, the number of new plants in next year's crop is considerably cut back.

Rhinocyllus conicus was first imported into this country from Italy and Switzerland in 1969 by SEA researchers at the Biological Control of Weeds Laboratory in Albany, Calif. It was released in several locations across this country, including the Gallatin Valley in Southwestern Montana, a musk thistle "hot spot."

Because of the weevil's success in reducing musk thistle populations in the Gallatin Valley, last spring a squad of insect gatherers led by SEA entomologist Norman E. Rees, Bozeman, Mont., collected over 70,000 of the insects. These weevils were released in Utah, Nebraska, Kansas, Wisconsin, Minnesota, and other musk thistle "hot spots" to start new *Rhinocyllus conicus* populations.

Rees has studied *Rhinocyllus conicus* and says that the weevil feeds only on musk thistle and several related thistles, including the Canadian thistle.

He also says that *Rhinocyllus conicus* should control but not eradicate musk thistle, and the weevils can be used in conjunction with herbicides to provide maximum musk thistle control if the chemicals are properly and carefully applied.

Mr. Norman E. Rees is located at the Rangeland Insects Laboratory, Montana State University, South 11th Avenue, Bozeman, MT 59717.—*L.C.Y.*

Flushing Out the Heat

POTTED PLANTS in nurseries need sunlight, but when the sun shines on one side of a pot all day long, the pot temperature can rise high enough to kill roots outright or prevent root growth. Growers often won't detect the damage until they try to transplant these injured plants the following spring.

John R. Potter, plant physiologist, and Miles McCoy, technician, at the SEA Ornamental Plants Research Laboratory, Corvallis, Oreg., borrowed an idea from Bruce Briggs, Olympia, Wash. nurseryman, to design a system for overcoming this hazard.

Passing about 100 milliliters of water through potting mix at 2-hour intervals from 10 a.m. to 4 p.m. daily, cools down the mix and protects the plant's roots. If a well-draining potting mix is not used, the mix may become water-logged. Also, the excess water could cause problems in mineral nutrition unless carefully monitored.

The Ornamental Plants Research Laboratory is located at 3420 Southwest Orchard Street, Corvallis, OR 97331.—*L.C.Y.*

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